WATENV – Water, Soil and Vegetation

Lecture 10

10. Physical parameters

10.1 Primary production and energy budget in waters

- In amphibic areas of waters, the productivity of reeds surpasses the productivity of terrestrial vegetation, e.g. *Phragmites australis* with 19 t/ha and *Typha latifolia* with 45 t/ha per year.
- Emerse hydrophytes are competing for light just like terrestrial species
- Submerse hydrophytes can only settle a restricted surface-near zone of a water body due to losses of light.
- Especially in shallow eutrophic waters, light is the dominating factor for phytomass production and nutrient consumption.

10.2 Light and shadow plants

- Almost all submerse macrophytes can be classified as shadow plants, as their maximal photosynthesis rate is reached at less than half of the full solar radiation
- However, not all emerse hydrophytes and helophytes can be classified as light plants
- For those plants, the photosynthesis rate of each individual can decrease with declining light and nutrient levels and reducing water movement.
- The efficiency of photochemical processes, called **quantum revenue**, is depending on the energy of the available light quantums and thus on the light‘s wavelength.

10.3. Compensation point

- The depth-depending distribution of submerse hydrophytes is mostly depending on the net photosynthesis rate, in case it is not restricted by water movements, hydrostatic pressure, carbon shortages or toxic substances
- At the lower boundary of the theoretical hydrophyte distribution, the gross photosynthesis rate compensates the respiration losses
- This is where the **compensation point** is reached.
- In limnic systems, the compensation point of the primary production equals the annualy shifting **compensation plane**, which separates the sufficiently bright **trophogenic** (euphotic) **zone** from the dark **tropholytic** (aphotic) **zone**.

10.4. Light stress

- Hydrophytes differ from each other concerning their adaption to certain light intensities
- Submerse plants occur in dark localities with a low light compensatrion point,
- Several natant and amphibic species have an extremely high light compensation point
- *Lemna trisulca* is a member of the first type, while *Littorella uniflora* or *Potamogeton polygonifolius* belong to the second.
- Although there are no special modifications for adaptions to different light qualities, there are certain typical reactions to changing light intensities, like changes in the chlorophyll density.
- Another reaction to differing light levels in the water is a movement of chloroplasts in the epidermal cells of several hydrophytes, like *lemna trisulca*.
- This process is called **phototaxis**
- The chloroplasts align horizontally to the light at low light levels and vertically to the light at high light levels, in order to increase or reduce the exposure to the light.

10.5 Water movement and its origins

- **Shear forces** and **abrasion**, that put a strain on hydrophytes, are caused by currents and wave action.
- Thus, current-rich parts of streams and wind-influenced shore zones with stronger water movement are mostly poorer in species and show a lesser amount of vegetation, while habitats rich in species and individuals can be found in protected coves and in zones with reduced currents.
- The major factors for **water movements** are solar energy and gravity. In limnic systems, surface warming and cooling lead to **circulation movements of water bodies** not directly affecting hydrophytes
- Mechanical strain in surface areas can be caused by **waves** that are induced by thermal winds.
- For the creation of vegetational structures at the **shores** of limnic systems and broad streams, wave action can be significant: waves have **mixing effects** in open water bodies; however, small waves have only minor effects in freshwater systems
- Waves are **surface-near rotating water rollers**, caused by wind action or vehicles

10.6. Currents

- While waves only move surface-near parts of a water body, currents in flowing waters mostly affect the **whole water body**.
- **Currents** cause erosional and accumulation processes in flowing waters and create a variety of flowing water structures:
- **Point bars** and **cut** banks,

- **Gravel-, sand-** and **mud islands**,
- **Potholes** and **shallow banks**
- In the potamal of flowing streams, swinging of the highest velocity's course usually causes the formation of **cut banks** and **point bars**.
- The **course of the highest velocity** in flowing streams swings from shore to shore, influenced by geogenic and phytogenic structures.
- Its **closest proximity** to the shores is reached at the cut banks, yet without actually reaching the shore
- Depending on the given current velocity, the stream bed at **cut banks** is deepened by erosion, covered with coarser substrate and in permanent movement.
- The stream bed at **point bars** is shallow. In the slow-moving water, fine-grained mineral and organic substrate is deposited.
- At artificially straightened parts of flowing streams that are situated in a potential meandering zone, "**phytogenic meander initials**" occur due to the slope.
- **"Phytogenic meander initials",** formed by the reed *Nasturtium officinale*, in a lowland stream, lead to a significant diversion of the course of the highest velocity. Which was formerly straight and now swings from shore to shore